

CLAIMS

What is claimed is:

- 1 1. A method comprising:
2 covalently bonding a thermal interface material to a bottom surface of a heat
3 dissipating device and/or a backside surface of a heat generating device; and
4 thermally coupling the heat dissipating device to the heat generating device, the
5 thermal interface material disposed between the bottom surface of the heat dissipating
6 device and the backside surface of the heat generating device.
- 1 2. The method of claim 1, wherein covalently bonding the thermal interface
2 material to a bottom surface of a heat dissipating device and/or a backside surface of a
3 heat generating device comprises electropolymerization of a monomer.
- 1 3. The method of claim 1, wherein covalently bonding the thermal interface
2 material to a bottom surface of a heat dissipating device and/or a backside surface of a
3 heat generating device comprises electrodeposition of an electroactive polymer.
- 1 4. The method of claim 3, wherein electrodeposition of an electroactive polymer
2 comprises electrodeposition of an electroactive polymer on a metal surface of the heat
3 dissipating device.
- 1 5. The method of claim 3, wherein the electroactive polymer has an electroactive
2 end group -NH_n^+ .
- 1 6. The method of claim 3, wherein the electroactive polymer has an electroactive
2 end group -COOH or -COO- .
- 1 7. The method of claim 1, wherein covalently bonding the thermal interface
2 material to a bottom surface of a heat dissipating device and/or a backside surface of a

3 heat generating device comprises surface grafting a polymer on the bottom surface of a
4 heat dissipating device and/or a backside surface of a heat generating device.

1 8. The method of claim 1, wherein covalently bonding the thermal interface
2 material to a bottom surface of a heat dissipating device and/or a backside surface of a
3 heat generating device comprises chemically treating the backside surface of the heat
4 generating device to generate a functional group that can react with the thermal
5 interface material to form covalent bonds.

1 9. The method of claim 8, wherein chemically treating the backside surface of the
2 heat generating device comprises oxidizing a silicon surface of the heat generating
3 device with an oxidizing agent.

1 10. The method of claim 9, wherein the oxidizing agent is KMnO_4 , and the thermal
2 interface material comprises an epoxy resin.

1 11. The method of claim 1, wherein the heat generating device is an integrated
2 circuit and the heat dissipating device is an integrated heat spreader.

1 12. The method of claim 11, wherein the thermal interface material has a bulk
2 thermal conductivity greater than 4 W/mK.

1 13. A method comprising:
2 applying a thermal interface material to a backside surface of a heat generating
3 device and/or a bottom surface of a heat dissipating device, wherein the thermal
4 interface material comprises a polymer material with thermally conductive filler
5 components dispersed therein, the thermally conductive filler components covalently
6 bonded together and/or covalently bonded with the polymer material; and

7 attaching the heat dissipating device to the heat generating device, the thermal
8 interface material disposed between the backside surface of the heat generating device
9 and the bottom surface of the heat dissipating device.

1 14. The method of claim 13, wherein the TIM comprises a molecular composite
2 material with covalent bonding between metal or ceramic filler components.

1 15. The method of claim 13, comprising producing the thermal interface material by
2 chemically treating metal or ceramic filler components to form a functional group that
3 can react with the polymer material to form covalent bonds.

1 16. An apparatus, comprising:
2 a heat generating device;
3 a heat dissipating device thermally coupled to a backside surface of the heat
4 generating device; and
5 a first thermal interface material disposed between the backside surface of the
6 heat generating device and a bottom surface of the heat dissipating device, the first
7 thermal interface material covalently bonded to the bottom surface of the heat
8 dissipating device and/or the backside surface of the heat generating device.

1 17. The apparatus of claim 16, wherein the heat generating device is an integrated
2 circuit.

1 18. The apparatus of claim 17, wherein the first thermal interface material
2 comprises an epoxy resin covalently bonded to the backside surface of the integrated
3 circuit.

1 19. The apparatus of claim 16, wherein the first thermal interface material
2 comprises a molecular composite material.

- 1 20. The apparatus of claim 16, wherein the first thermal interface material
2 comprises a nanocomposite material.
- 1 21. The apparatus of claim 16, wherein the first thermal interface material
2 comprises a thermally conductive polymer.
- 1 22. The apparatus of claim 16, wherein the first thermal interface material has a
2 thermal conductivity greater than 4 W/mK.
- 1 23. The apparatus of claim 16, comprising an electroactive polymer bonded to the
2 heat dissipating device by electrodeposition.
- 1 24. The apparatus of claim 16, wherein the heat dissipating device is an integrated
2 heat spreader.
- 1 25. The apparatus of claim 24, comprising a heat sink thermally coupled to a top
2 surface of the integrated heat spreader.
- 1 26. The apparatus of claim 25, comprising a second thermal interface material
2 disposed between the top surface of the integrated heat spreader and a bottom surface
3 of the heat sink, the second thermal interface material covalently bonded to the bottom
4 surface of the heat sink and/or the top surface of the integrated heat spreader.